Discover the RF Attenuator

The RF attenuator is a versatile, but underutilized, piece of equipment. Most often used in "foxhunting," the device can come in handy for a variety of other purposes as well. N9SFX shows us some of the uses he's discovered.

By Pete Ostapchuk, N9SFX*
(n9sfx@aol.com)

Do you have an RF attenuator in your shack? I doubt it. I've worked in electronics since 1966, including a three-year stint as an Army radar operator, and I've been a ham since 1993. But until I built one, I had never seen an RF attenuator in the "flesh." What *is* an RF attenuator? Simply put, it's a device that absorbs radio frequency (RF) energy, reducing the strength of the signal on the output from what it was at the input. They're used when very low powered signals are required.

My First Attenuator

I built my first RF attenuator three years ago, at a time when there was a lot of interference on the local repeater. I was part of the direction-finding (DFing) team trying to track down the source of the interference, I had a five-element Yagi antenna and was pleased with its performance (Photo A), but a problem arose when DFing stronger signals. Once I got close enough to the signal to start zeroing in, the signal strength got so high that the S-meter read full scale no matter where I pointed the antenna! So I built an attenuator[1] that would go from 0 to 95 dB (decibels) in 5 dB-steps, and that enabled me to get a whole lot closer (Photo B).

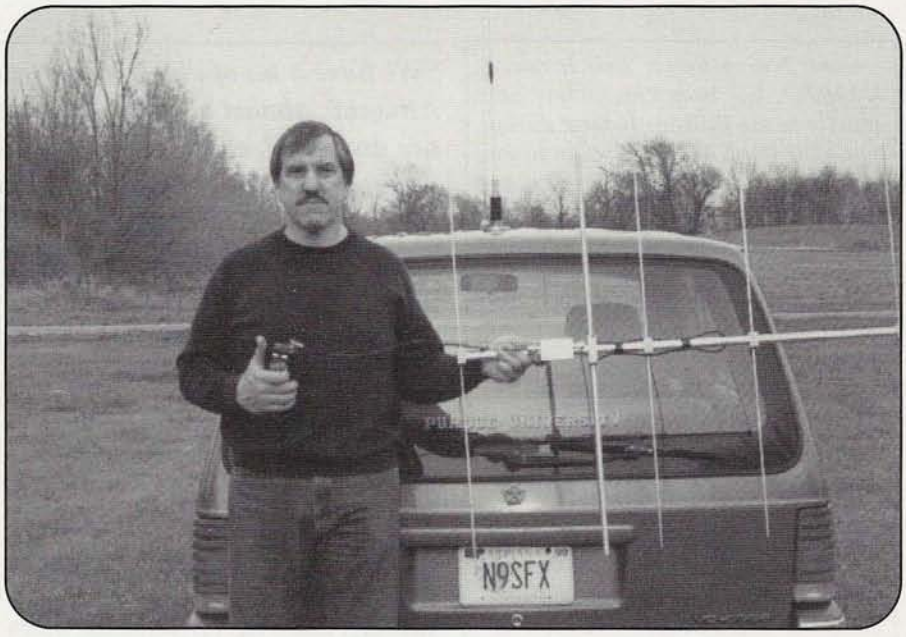

Photo A. The author, set to begin tracking down a mystery transmitter, with his HT, RF attenuator, and five-element Yagi. (Photos courtesy of the author)

It's easy to use. All you need to do, when the signal starts getting too strong, is to connect an attenuator between the antenna and the radio (Photo C) and select enough attenuation, approximately 5 dB, to get the S meter back into the active region. Keep moving toward the transmitter you're hunting and keep increasing the attenuation as necessary until you either trip over the transmitter or run out of attenuation. Theoretically, 95 dB should allow you to get closer to your target, or the "fox," by a factor of 56,000; but ours is not a perfect world, and you may run out of attenuation. If you do, you still have a number of options open to you. (A good source of foxhunting tips is a book entitled *Transmitter Hunting—Radio Direction Finding Simplified*, by Joe Moell, KØOV, and Thomas Curlee, WB6UZZ[2].)

After designing and building several working units, I began to get requests for modifications, namely more attenuation and smaller steps. Obviously, there are people out there with applications for attenuators that do not involve foxhunting. The attenuator is just a tool, like a volt-

Pete Ostapchuk, N9SFX, has been a ham since 1993, and an Extra class operator since 1994. He lives in Osceola, Indiana, where he is a volunteer examiner and volunteer ARRL Technical Specialist. He's currently working with the Civil Air Patrol to see if there are ways for hams with direction-finding skills to help speed up searches for downed aircraft.

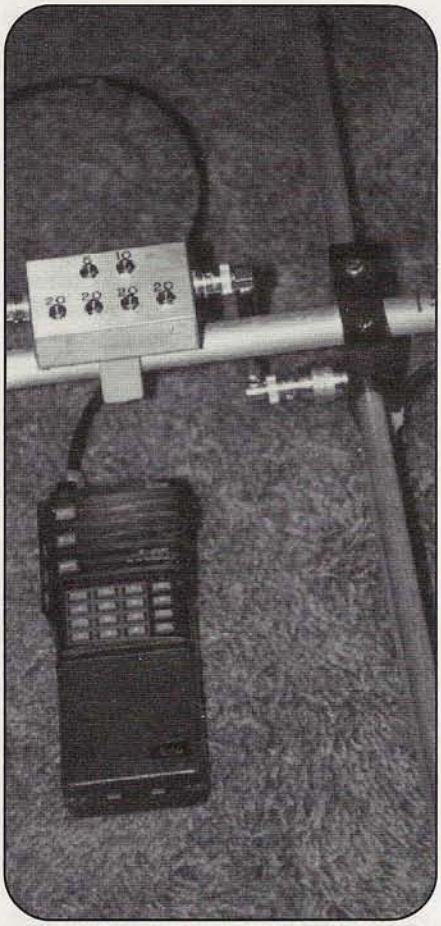

Photo B. Close-up view of N9SFX's 95-dB attenuator, clamped onto the mast of his antenna and connected to both the antenna and radio.

meter, and can be used in many different disciplines. Let's take a look at a few.

Mapping Repeater "Hot Spots"

The first non-foxhunting application I experimented with was using my attenuator to help me map out my house to help me find hot spots to solidly get into a local repeater. I took the rubber duck off my HT, attached the rubber duck to the attenuator, and attached the attenuator to the HT with a double male adapter, as shown in Photo C. I waited for the Monday night net to start and I began increasing attenuation between the antenna and the HT until the S meter read less than full scale. Now it was a simple matter to walk through the house and note where the S meter read the highest. These hot spots are where I want to be to hit the repeater with the least amount of power. Because of *antenna reciprocity*, if I can hear the repeater well, it can hear me well. This applies only when a single antenna is used for both transmit and receive, and will not always work if the repeater uses separate receive and transmit antennas.

A Transmit Attenuator

My second experiment involved transmitting through my attenuator. By transmitting through the attenuator I was able to determine the minimum power needed to access a certain repeater. This information can be kept in a log which will tell you how well your repeater is receiving over the years. It's a simple test, just talk to someone on the repeater and note how much attenuation your transmitter can tolerate before the person on the other end can no longer understand you. It's best to always use the same transmitter and antenna and talk to the same person. One thing you need to remember is that the transmitter should not put out more power than the rating of the resistors in the attenuator. In other words, if your attenuator uses 1-watt resistors, don't transmit into it with more than 1 watt.

The latest use I had for the attenuator was to connect my signal generator to my field strength meter. My field strength meter has a range of 88 to 220 MHz and is quite selective, but I needed to calibrate the tuning capacitor in the LC circuit in order to put graduations on the box so the knob could be rotated to the frequency of choice. The signal generator had too much output for the field strength meter, so I ran the signal generator output through the attenuator and then into the field strength meter.

If you don't have a signal generator, you can use a transmitter, but you might need a fixed-value power attenuator between your transmitter and the step attenuator if the low-power setting of your transmitter is higher than the power rating of your step attenuator. If you know the power output of your transmitter and the power-handling ability of your step attenuator, you can calculate the amount of attenuation needed in the power attenuator by using formulas that appear later in this article. This process will work with other pieces of test equipment that won't tolerate the amount of power coming from the device you're testing.

A Mini Antenna Range

If you build antennas or just want to test a store-bought antenna to see how

Jun's Electronics
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1-800-882-1343
California
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310-390-8003 FAX 310-390-4393
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e-mail: radioinfo@juns.com

AR-146 $169.95
2 Meter Mobile
• Receive 130-180 MHz
• 3 Power Settings 5,10,50 Watts
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IC-3SAT
220MHz, FM, Handheld
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• Full 5 Watt Output w/13.8 VDC
• Convenient Keyboard For a Variety of Functions
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• 48 Memories
• CTCSS Encode Included

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BP-173 9.6V 600 mA $49.95
IC-B157A 7.2V 900 mA Battery $49.95
AT-600 2/440 HT 2.5W $199.95
AT-400 440 MHz HT with Alkline AA Battery Case $119.95
Prices subject to change without notice

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CULVER CITY, CA 90230
2 1/2 miles from LAX-North on I-405
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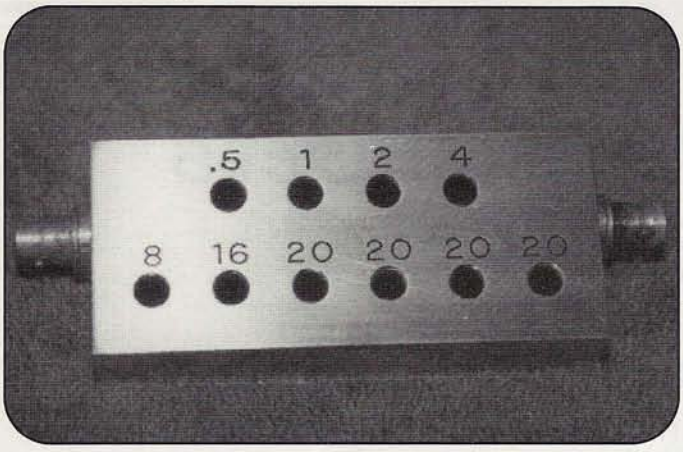

Photo D. Attenuation values are engraved into the cover of the N9SFX attenuators. This is the cover of the 10-switch unit, which provides up to 111.5 dB of RF attenuation in .5-dB steps.

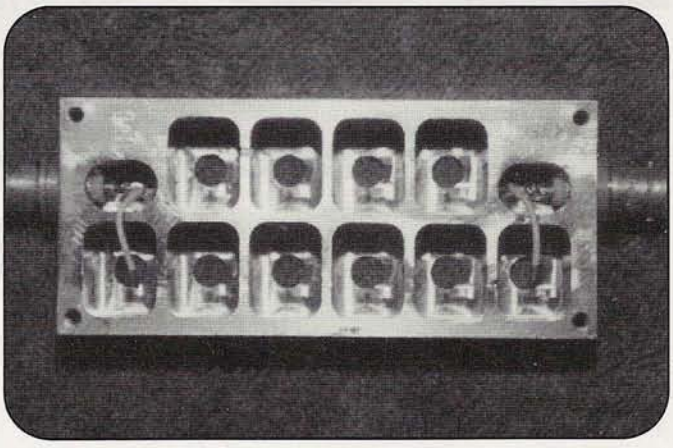

Photo E. Interior of the N9SFX attenuator before resistors and switches are added. The device is made from a machined block of aluminum.

the half power point, but as you can see from the example above, it's really 3.0103. It's only an error of one third of one percent, so unless you work for NASA, you can let it slide.

It's an easy matter to work the formulas backwards. If you have a gain of 20 dB, divide 20 by 10 to get 2; the number 2 becomes the exponent of the number 10; 10 to the power 2 is 100, and you have a power gain of 100. If you divide 20 by 20 to get 1, 10 to the first power is 10, you have a voltage gain of 10, which is also a power gain of 100 (following the formula above that 2 x voltage = 4 x power, 3 x voltage = 9 x power, then 10 x voltage = 100 x power).

Where Do I Find an RF Attenuator?

Now you know some of the things that can be done with this handy tool that will never have dead batteries, but you need to find one before you can plug it in. There are several commercial units out there, but most run anywhere from $200 to $1,000. MFJ, however, makes one in the $70 range. I hear tales of attenuators showing up at hamfests at reasonable prices, but the standard hamfest rule of "buyer beware" applies. Kits are very rare; I've read about one that's built from little pieces of pc board soldered together, but I don't know if it's still available.

I have a couple of different kits available, one a six-switch unit and the other a 10-switch unit. (These are the attenuators that were featured in, respectively, the May[1] and December, 1998[3], issues of *QST*.) The six-switch unit is used almost exclusively for foxhunting and has attenuation values of 5, 10, 20, 20, 20, and 20 dB (total 95 dB). Other values are available, but the ones just mentioned are the standard values. It works well up to 450 MHz. The 10-switch unit will do everything including foxhunting, as it's only 3-7/8 inches long, not counting the BNC connectors. The standard attenuation values for this unit are .5, 1, 2, 4, 8, 16, 20, 20, 20, and 20 dB (total 111.5 dB, with significantly smaller steps than the 6-switch unit).

Both units have the attenuation values engraved into them (Photo D), and non-standard values are hand stamped. The housings are machined from solid blocks of 6061-T6 aluminum (Photo E) and are rugged to the point that they will support a weight of several tons. Both models are available with everything needed to build a completed unit including resistors and switches. See "Resources" for prices and ordering information. The units come with lots of instructions.

However you decide to get it, just go ahead and get it, you never outgrow your need for tools. A good attenuator should last you a lifetime. ■

"A good attenuator can help you test your S-meter to see if it is graduated accurately. If your S-meter is not accurate, your attenuator can show you where the 3-dB and 6-dB points are...or you can check for other steps of your choosing."

References

1. Ostapchuk, Pete, N9SFX, "A Rugged, Compact Attenuator," *QST*, May, 1998, pp. 41–43.
2. Moell, Joe, KØOV, and Curlee, Thomas, WB6UZZ, *Transmitter Hunting—Radio Direction Finding Simplified*, TAB/McGraw Hill #2701; Tab Books, Division of McGraw-Hill, Inc., Blue Ridge Summit, PA 17294-0850; Phone: (717) 794-2191; Fax: (717) 794-2103.
3. Ostapchuk, Pete, N9SFX, "Rugged, Compact Attenuators Improve," Technical Correspondence, *QST*, December, 1998, pg. 64.

Resources

RF attenuator kits are available from the author for either $45 or $59, depending on whether you order a six- or 10-switch unit. If you have a supply of switches, you can save yourself $12 or $20, respectively. That price includes shipping, but foreign orders are $2 additional for shipping. To order, send a check or money order to Pete Ostapchuk, N9SFX, 59425 Apple Rd., Osceola, IN 46561. For more information, send a self-addressed stamped envelope (and your question) to the above address, or contact Pete via e-mail at n9sfx@aol.com.

The MFJ-762 RF attenuator sells for $69.95. To order, or for more information, contact MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, MS 39762; Phone: (601) 323-5869 (8–4:30 Central time, M–F); Orders/Dealer Locations: (800) 647-1800; Fax: (601) 323-6551; Web: <http://www.mfjenterprises.com>.